SPADEX

1.3.1999 – 30.9.2001

Short description of IFC Project

Final Report

CONTENTS:

1. Summary

This report presents the results of SPADEX – a project which tested the use of a product model and data sharing in IFC format in a simulated building process. One aim of the project was to define data that could be utilised by different parties of a building project, and examine how this data was supported by IFC. Another was to test data transfer in practice between the project participants, which represented different parties of a building project.

Implementation

The project was carried out by defining the information requirements of the parties of a building project, developing means for handling this information and testing the readiness of the IFC format for use in practice in a series of data transfer tests.

Observations

During the project, several difficulties concerning the data transfer were discovered. The problems included software-specific requirements for modelling and transferring, lack of IFC guidelines for different applications and large IFC file sizes. These findings emphasize the importance of ongoing and further IFC research and efforts by software developers.

Results

The experiences from this project has brought forward issues that need further development if the IFC format is to be used efficiently and reliably in an actual building project.

Although some of the results presented are specific to this project, hopefully this report will provide information for further IFC development by presenting some challenges and suggestions for improvement.

2. Background

The point of departure of this project was EU 1077, COCON and FinnCore. As a result of these projects, the definition and piloting of product model based data transfer was achieved. The purpose of the SPADEX project was to implement the results of this research.

3. Implementation

The project is divided into four parts:

Part 1:
- Defining the information needed by the parties and the applicability of IFC version 1.5.1 for implementation.

Part 2:
- Developing the means of handling the information needed by the parties.

Part 3:
- Implementing IFC version 1.5.1 as a part of the COVE application, based on the results from Parts 1 & 2.

Part 4:
- Testing data transfer between the parties and the IFC compatibility of the COVE application in practice.

3.1. Description of the data transfer process

This part describes the contents and realisation of Part 4, in which data transfer in IFC format was tested between the project participants. The idea was to simulate, in a small scale, data sharing between the parties of an building project. The test target was a model of the Shopping Centre Länsikeskus in Espoo, Finland.

In the first phase, several preliminary tests were made using ADT / Autodesk (Tomi Henttinen, CAD-Q , formerly AIO –GROUP and Seppo Niemioja, Arkkitehtitoimisto Innovarch)
as modelling tool for the architectural model. *See Appendix 1*

In the final phase, a space program of the test target was made with Excel / Microsoft. This data was then transferred to Visio / Microsoft, and a space model was created.
The space model was transferred to ArchiCAD / Graphisoft. In ArchiCAD, the space model was used as base for the architectural model (Lauri Melvasalo and Antti Korkkula, M.A.D. and Seppo Niemioja, Arkkitehtitoimisto Innovarch) and Allplan / Nemetschek (Peter Neidhart and Mikael Moberg, Laserlaskenta and Seppo Niemioja, Arkkitehtitoimisto Innovarch).

The original models were made by Seppo Niemioja, and corrections and additions to the models were made by M.A.D and Laserlaskenta.

The models were exported as IFC files, which were imported back to the applications. Transfers of the files were also made between the applications. Comparisons were made between the transfers.

The architectural model was then imported to Allplan by the structural engineer (Antti Pekkala / A-Insinöörit) , who made modifications to the structure.

The HVAC engineer (Tuomas Laine / Insinööritoimisto Olof Granlund) imported the model to RIUSKA, dimensioned the ventilation requirements based on data from the model. The information was transferred in IFC from RIUSKA to MagiCAD. The ventilation ducts were modelled with MagiCAD and exported in IFC.

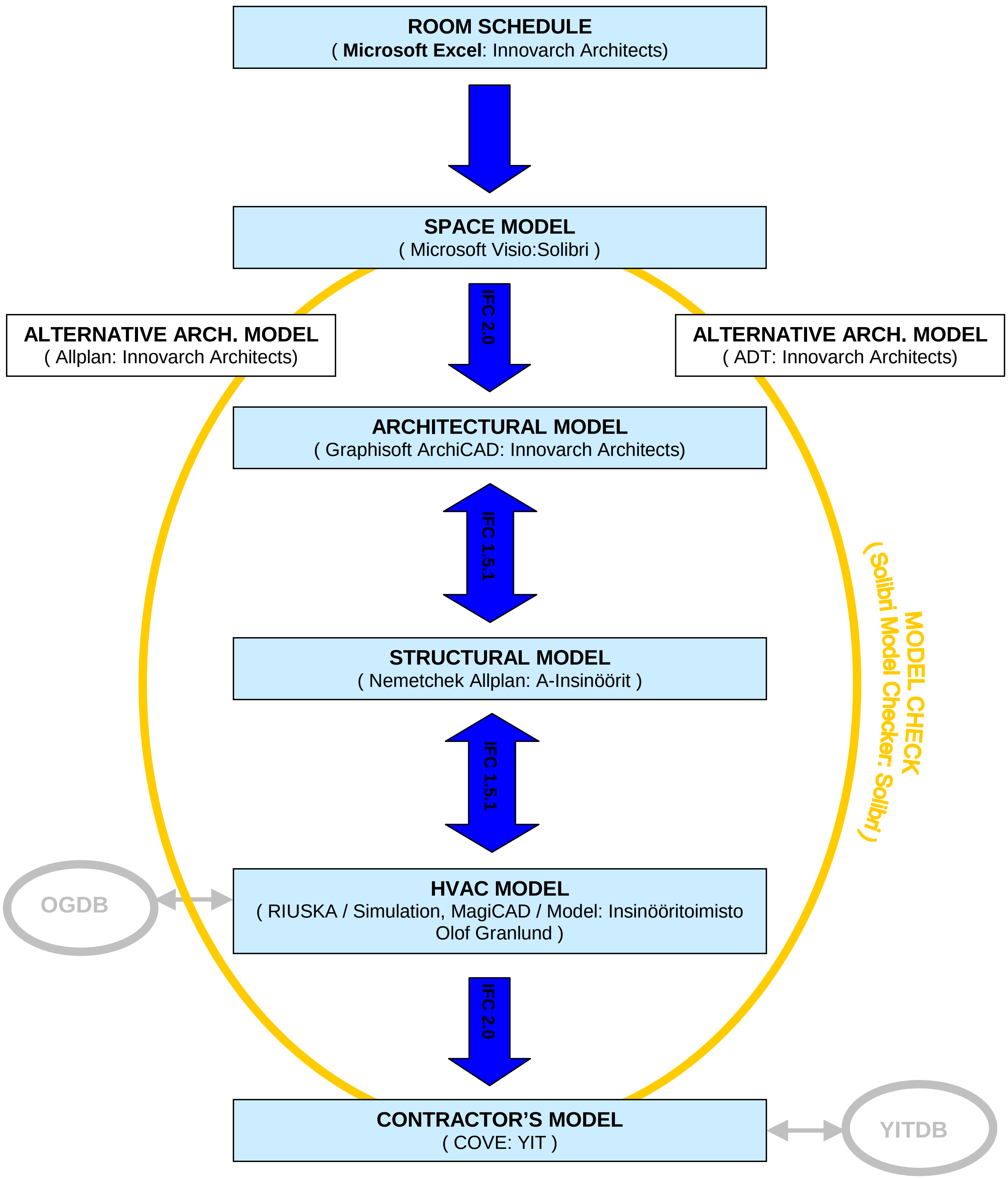
After each phase, the model was exported to the other project participants.

The contractor (Susanne Backas / YIT) imported the model to COVE. The modelled was checked with a built-in version of Solibri Model Checker. A quantity calculation was made based on the data from the model. The project was also scheduled and visualised in 4D.

The model was checked with Solibri Model Checker after each export, and possible errors were reported to the participants. *See Appendix 3*

The process was tested in real-time in a workshop on August 10th, 2001. *See Appendix 4.*

Diagram of the data transfer process



3.2. Changes during the project

During the course of the project, IFC version 2.0 was released. Some applications used in the project supported both IFC versions 1.5.1 and 2.0, while some supported either version.

In the last phase of the project, both versions of IFC were used. This caused some difficulties in the data transfer tests, as the model was not always transferred directly between the participants in all phases of the test. Instead, the model had to be transferred via an application that supported both IFC versions.

4. Observations

4.3. Challenges

- ***Lack of software-specific IFC documentation***
- ***Loss of information***
- ***Distortion of geometry***
- ***IFC file size***
- ***Legal liability***
- ***Managing and utilising the data in the model***
- ***Varying CAD modelling practices***

4.3.1. Lack of software-specific IFC documentation

Lack of up-to-date IFC documentation for different applications was considered a serious problem. Adequate information about the IFC compatibility of the applications used in the project (supported IFC entities, instructions for exporting and importing IFC files, etc.) would have been important to avoid errors in the test transfers that were caused by the users. As described in part 3.3.7., it is also important to create guidelines for modelling.

By the end of this project, one software producer (Graphisoft / ArchiCAD) has released a documentation of the compatibility with IFC 2.0 of their application, which also contained some user guidelines for managing IFC files. The Graphisoft IFC Reference Guide can be downloaded from the following address: http://www.graphisoft.com/products/ifc_support/

Another software supplier, (Laserlaskenta / Allplan) has provided guidelines for IFC data transfer. *See Appendix 5*

4.3.2. Loss of information

The applications used in the project have different ways of handling attributes for components. If the values for the attributes are not contained in the IFC file (i.e. the values have not been set in the previous application), the application usually sets a default value for the attribute, which is then saved in the IFC model and included in the next transfer. This way, it is difficult to know in which phase the value of a certain attribute was set. It would be useful to add a filter for such components in the IFC export.

There were also cases where the model data was transferred incompletely or not at all between applications. *See Appendix 2*. It is possible that some of these cases were a result of insufficient information about correct settings for IFC import and export in the applications that were used. *See Appendix 5 (In Finnish)*

4.3.3. Distortion of geometry

In some of the tests, the component geometry was distorted. There were also some problems with mapping the coordinates of components which were added to the model in different applications. *See Appendix 2*. Due to insufficient comparison material (the tests in question were made between only two CAD applications), the source of the problem was not definitely confirmed.

4.3.4. IFC file size

In this project, the same model was transferred between the different participants and data was added to the model in each stage. This resulted in very large IFC files, considering the size of the project and the size of the original ArchiCAD file. *See Appendix 2*. In a real building project, the amount of data to be handled would be considerably much larger and difficult to handle with standard capacity computers.

New IFC versions (2.x ->) will bring solutions to some parts of this problem, especially the managing of HVAC data. Nevertheless, this does not solve the main problem, which is that the whole model needs to be handled throughout the process. A better long-term solution would be the ability to handle separate parts of the model. (See next paragraph.)

4.3.4.1. Lack of file sharing possibilities

To reduce the amount of unnecessary data that is transferred between the project participants, the model could be divided into parts, so that instead of transferring the whole model, the participants would export only the components they have added or modified (See part 3.3.5.)
However , when the model is split into parts, the relations between components are lost. Relations are needed for tracking conflicts in the model and for calculation of quantities.

Example:

The connections between HVAC ducts and other components in the model can be visualised in 3D, which is a benefit since possible collisions between components can thus be detected visually. Still, the model does not contain the relations between the ducts and surrounding components in the model. These relations are needed for automatic checking of overlapping components or for obtaining correct quantity data from the model, including perforations for ducts in surrounding structures, etc.

4.3.5. Legal liability and project organizing

In a typical project, several different parties are working with the same model. For liability reasons, it is necessary to define different user rights for the participants in the beginning of the project. Different user-rights could include, for instance, making modifications to certain components in the model or viewing certain parts of the model, and so on. The components should also contain information about who has created / modified it.

Example:

A load-bearing column. The space reservation for the column is property of the architect while the column itself is property of the structural engineer.

Another important issue that should be taken into account is that working on a single model is not compatible with a normal project schedule. In the design phase, all participants (architect, building services, structural engineer, etc) should be able to work simultaneously with the same model.

4.3.6. Managing and utilising the data in the model

The possibility to attach other data than 3D objects to the IFC model is a subject that should be studied further. A real building project contains data that is not reasonable or even possible to model in 3D. Even though it is possible to include certain non-3D data as properties to components in the IFC model, the ability of different applications to read this data varies.

4.3.7. Varying CAD modelling practices

The level on exactness which is normally required for 2D documents is not sufficient for IFC data transfer. Some “mistakes” in the model – or even deliberate modelling solutions that are irrelevant in 2D documents, can cause errors when interpreted by other applications. The data of the 3D model can be utilised by a number of applications, which all have their own software-specific requirements. Therefore, it is important to define the “rules” for the data transfer in the beginning of a project.

- What information needs to be included in the model at each stage (e.g. level of detail)
- What will the data in the model be used for (e.g. cost estimation, thermal simulation, etc.)
- What applications will be used (software-specific requirements for modelling)

It is also important to define what causes problems in different applications and to provide adequate guidelines for modelling. The Solibri Model Checker application, which was used in the project, is an example of a useful tool for tracking problems in the CAD model.

Conclusions:

The participants of a typical building project have very different needs for information. The challenge is creating a product model that can meet all these requirements.

Using a product model calls for a shift in attitude by the users, particularly the designers – a change from a document-based approach towards model-based thinking.

5. Results

The transfer of the test model in IFC has been realised. Data transfer has been tested in practice between the participants and the results of the tests have been documented. The application-specific guidance provided by the software producers and suppliers has been used in the data transfer tests.

The project has provided practical information about the use of a product model in a building project, which can be used in the future development of IFC compatible applications and in providing guidelines for participants in the data transfer process.

The experiences from the project have been used in the development of two applications, COVE and Solibri Model Checker, of which the latter is a commercial product.

In the beginning of the project, a survey was made of attributes that can be linked to space objects and the IFC 2.0 compatibility of this data. See Appendix 6. In IFC, this data can be linked to a space object as properties. The idea was to find a method to transfer the data from a room schedule to a 3D space model.(see also part 4.4.)

One aim of the project was to test the applicability of IFC version 1.5.1. for use in practice. Based on the tests made in this project, the conclusion is that even though there is potential for further development of new IFC versions, as for now the IFC version 1.5.1 is not suitable for use in an actual building project. One reason is, among other things, the lack of adequate software-specific documentation for this version. Furthermore, there is very little documentation of known software bugs and limitations. This complicates use, especially as there is no common standard for CAD modelling with regard to IFC.

The main problem which limits the use of IFC version 2.0 in production in Finland is the limited amount of software that supports this version.

5.4. Possible further research

– **Space model tool:**

A tool for generating a space model from a room schedule in Excel format, which would include circumstancial demands for spaces and could be transferred further to a CAD application, has been suggested as a topic for further research. The space model would serve as basis for the architectual design model. Decisions about a possible research project have not been made.

During this project, several alternatives among existing, commercial software were considered as tools for generating a space model. ALBERTI software by Nemetschek was tested, but it was not considered an optimal tool for early design work.

– **Pilot project**

A pilot project would complement the results of this project.

6. Seminars

The project has been presented at the TEKES Vera seminars in Washington, D.C, U.S.A. 14.4.1999, in Chicago 19.6.2001 and Vantaa, Finland 20.11.2001.

7. Participating organizations

Arkkitehtitoimisto Innovarch Oy (Innovarch Architects)
A-insinöörit Oy
CAD-Q Oy
Insinööritoimisto Olof Granlund Oy
Solibri Inc.
YIT Corp.

For more information, please contact:

Susanne Backas
YIT Corp.
e-mail: Susanne.Backas@yit.fi
tel. +358-204 33 111